# TECHNICAL MANUAL

# RADIATION MONITOR
# MODEL RM-15

**EBERLINE**
**Instrument Corporation**
SANTA FE NEW MEXICO

# TECHNICAL MANUAL

# ALPHA SCINTILLATION DETECTOR
## MODEL AC-3

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## SECTION I

## PURPOSE AND DESCRIPTION

A. PURPOSE

The AC-3 is a scintillation type alpha probe, designed for use with several EIC survey instruments.

B. DESCRIPTION

The AC-3 consists of a photomultiplier tube, dynode network assembly, scintillation crystal and optical prism, all enclosed in a light-tight housing.

C. 1. ACTIVE AREA: 59 $cm^2$ (9.1 $in^2$) within 5-3/4" x 2" sampling area.

2. WINDOW THICKNESS: 1.5 $mg/cm^2$ aluminized mylar.

3. SCINTILLATOR: ZnS (Ag) powder.

4. EFFICIENCY: 28% for alphas emitted from 59 $cm^2$ of a distributed area $Pu^{239}$ source.

5. UNIFORMITY: No single reading from a 1" dia. $Pu^{239}$ source deviates more than ±12% from the average reading.

6. OPERATING VOLTAGE: Nominal +1200 volts; however, the optimum voltage depends on phototube characteristics, cable length, and input impedance and sensitivity of counter.

7. OPERATING CURRENT: Nominal 10 microamps.

8. PLATEAU: With 1" dia. $Pu^{239}$ source, typically 200 volts long.

9. TEMPERATURE RANGE: -40° to +140°F.

10. CONNECTOR: Special EIC waterproof connector (CJ-1). Mating connector is EIC Model CP-1.

11. SIZE: Approx. 11" L x 2-3/4" W x 3-1/4" H.

12. WEIGHT: 1 lb. 6 oz.

## SECTION II

## OPERATION

A. OPERATION

1. After receiving and unpacking, inspect for shipping damage, especially the detector face assembly.

2. Connect the AC-3 to measuring instrument.

3. Determine the operating point on the AC-3 plateau and set to this point. See Step 5.

4. Begin monitoring. Monitoring techniques depend greatly on the situation at hand. Therefore, no specifics will be given. In general, the detector must be held within 1/4 inch of the surface being checked. Holding it in contact with the surface is the most consistent, but this holds the risk of puncturing or contaminating the face.

CAUTION

> Two cautions should be consistently observed while using the AC-3. 1) The cable connecting the AC-3 to an instrument must be hand tight ONLY. Use no tools. 2) The face of the AC-3 is very thin and easily punctured. NEVER set the detector on a sharp object. There is a clear plastic probe face cover supplied with each probe. It is a good policy to get in the habit of never removing this cover unless monitoring is to be done, then replacing it immediately.

5. Determining the Plateau: There are actually two plateaus for each AC-3. Although these are actually the same, the viewpoint is changed, depending upon which type of instrument the probe is being used with. If the instrument has a fixed HV and a variable input sensitivity (RM-3A, PAC-1SAGA, etc.) the plateau is a function of efficiency versus input sensitivity and is dealt with in part 5a. If the instrument has a front HV adjustment (PAC-4S, PRM-4, etc.) the plateau is a function of efficiency versus high voltage. This is the type of curve that is supplied with each AC-3, and is dealt with in part 5b.

a. Turn instrument on. Turn discriminator fully CCW. Place AC-3 over source. Start turning discriminator CW until instrument just starts to count. Record instrument reading and discriminator setting. Turn discriminator 1/16 turn clockwise and again record readings. Continue until discriminator is fully CW or until the plateau is passed and a definite rise in the curve is noted. The ideal operating point is just before this upswing occurs.

b. Turn instrument on. Turn HV adjust fully CCW. Place AC-3 over source. Start turning HV slowly clockwise until the instrument just starts to count. If an electrostatic voltmeter is available, monitor the high voltage. Otherwise, record the HV adjust position. Also record the instrument reading. Turn HV adjust CW 1/16 or 50 volts. Again record reading. Continue until the plateau is passed and a definite rise in the curve is noted.

CAUTION

> The HV capability of the instrument may exceed the tolerance of the AC-3. The HV must NEVER be advanced without watching the instrument reading.

The ideal operating point is 50 to 100 volts (or 1/16 to 1/8) below the point at which the upswing occurs. If no upswing occurs, the operating point should be 100 volts above the knee of the plateau.

## SECTION III

## MAINTENANCE

### A. DISASSEMBLY AND REASSEMBLY

1. FACE PLATE ASSEMBLY: The face plate assembly is retained by six O-ring screws around the edge. Removing these screws releases the entire assembly. To replace the detector face, remove the probe from its cable and remove these six screws. Pull the face assembly from the detector housing, being careful not to allow the optical prism to fall from the housing. Try not to touch the internal parts of the probe. Inspect these parts for fogging or dirt. If cleaning is needed, use a fresh Kleenex to wipe the surfaces clean. USE NO SOLVENTS OF ANY KIND. To reassemble, take the O-ring gasket from the defective face and fit it around the edge of the replacement face. Fit the face carefully into the probe assembly. Replace the six screws, starting all screws before tightening any one, and then tighten evenly all around.

2. PHOTOMULTIPLIER TUBE: The PM tube is removed by unscrewing the cable connector (strap wrench recommended). With the connector out, the tube is retained only by the bond of the optical coupling compound. Remove by pulling GENTLY on the spring while rotating the socket and PM tube with your thumb.

When replacing, make certain the end of the tube is clean and has a sufficient amount of coupling compound (approx. 1/4 teaspoon Dow-Corning 4X). Press in and rotate to firmly seat the tube.

3. TSN-4 DYNODE NETWORK ASSEMBLY: After removing tube and TSN-4 assembly, the TSN-4 can be detached from the tube by an easy back-and-forth and outward pull. The network can be replaced by the same movement inward. Before starting the replacement BE SURE EACH of the tube contact pins will engage in one of the connector receptacles in the TSN-4, or bent tube pins will result. Always handle the TSN-4 by the body - NEVER by the spring.

The TSN-4 has a gain adjustment on the side of the body which is wired so the most gain is obtained from the PM tube in the fully CW position. Any time that the gain adjustment pot is turned, the AC-3 plateau curve will be altered and must be run again. This control is set at the factory for a particular instrument use and should normally be changed only for a different instrument or in case of a photomultiplier replacement. When using with different instruments always try to reach the plateau with the external controls at hand (HV adjust or discriminator) before disassembling probe to adjust the gain control.

### B. REPAIR PROCEDURES

1. DETECTOR FACE DECONTAMINATION: Gently brush the face clean with a small camel hair brush. If contamination still clings, wash gently with clean water. DO NOT rub or the thin face may be punctured. If these measures are unsuccessful, the detector face assembly must be changed.

2. PATCHING DETECTOR FACE: If it is suspected that the detector has developed light leaks, small punctures can be repaired with the black lacquer supplied. Light leaks may be located by exposing the detector face to a direct light source and then shadow small areas of the face with the finger. As the shadow passes over the faulty area of the face, the meter reading will change. When the faulty area is located, cover the area with black lacquer. If the patch is complete, the meter reading will drop to zero. (Assuming no background from other causes.) If the patch

is not complete, proceed as outlined above until all leaks are patched.

CAUTION

> The patching lacquer will not pass alpha particles and readings must be corrected to compensate for the decrease in detector active area. Keep the patch as small as possible.

If the face has a great number of light leaks, or the faulty area of the face cannot be located because of saturation, replace detector face assembly.

## SECTION IV

## PARTS LIST AND DIAGRAM

The AC-3 consists of the following assemblies and parts:

AC-3 Probe Body

CJ-1 Connector Assembly

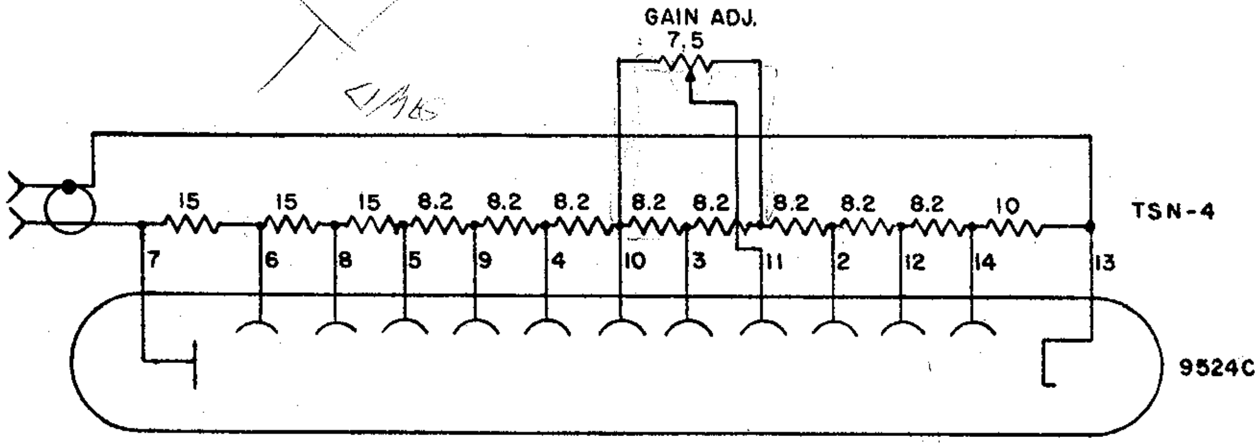
TSN-4 Dynode Network Assembly

EMI Type 9524C Photomultiplier Tube, selected for application

AC-3F Probe Face Assembly

AC-3FP Probe Face Protector

4/4/85



ALL RESISTOR VALUES IN MEGOHMS

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# MODEL RM-15

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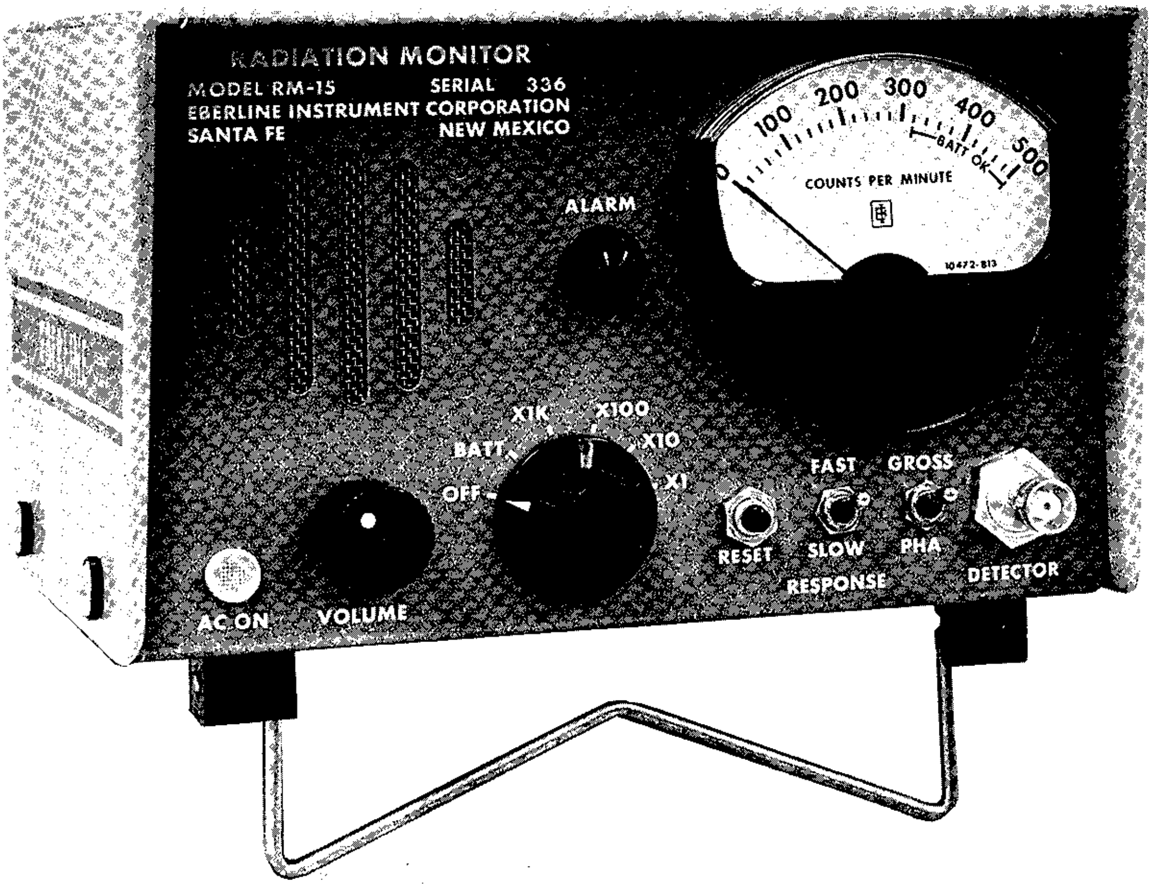

*Figure 1-1. Radiation Monitor, Model RM-15*

# SECTION I

# GENERAL

## A. PURPOSE AND DESCRIPTION

The RM-15 Radiation Monitor is a small, extremely versatile, alarming count rate meter, with single channel pulse height analyzer, for use with a wide variety of detectors. It is operated from a Ni-Cd battery which is trickle charged when the unit is plugged into the AC line. Four meter scales are provided of 500, 5K, 50K and 500K counts per minute full scale; and a speaker with volume control provides aural indication of the count rate.

The locking alarm point is adjustable over the scale of the meter by a rear panel control. When actuated, the alarm does not affect the meter reading and is indicated by a red light and a high frequency tone on the speaker.

The detector high voltage is adjustable over a wide range by a rear panel control. This allows setting the proper operating voltage of a geiger tube or to the plateau of a scintillation detector. This adjustment, along with window width, also sets the energy being counted when in the PHA mode. The voltage range of the standard unit is compatible with most scintillation and geiger detectors.

To utilize the pulse height analyzer feature of the instrument, the pulse height from the detector must be proportional to the energy of the radiation and vary with the high voltage applied.

Circuitry in the RM-15 is all transistor and integrated circuit, mounted on two plug-in boards. The top cover is easily removed for access to internal components. Rear panel connectors are provided for an external scaler, and a 50 microamp DC recorder.

## B. SPECIFICATIONS

### 1. INDICATOR

a. Visual

(1) Scale Length: 2.37 inches.

(2) Scale Marking: 0 to 500 CPM with 25 increments.

(3) Range: Switch controlled multipliers of X1, X10, X100 and X1K yielding 500, 5K, 50K and 500K CPM full scale.

(4) Response Time: FAST, 2 seconds; SLOW, 20 seconds (measured to 90% of final reading).

(5) Linearity: Within ±5% of full scale, typically ±2% of full scale.

(6) Battery Dependence: Calibration change less than 10% within BATT OK limits.

### 2. EXTERNAL CONNECTIONS

a. Scaler Output: 6V positive pulse, BNC connector.

b. Recorder Output: 50ua full scale, 1/4 inch, 3 wire phone jack.

c. Detector Input: MHV connector with variable high voltage to suit detector. Signal capacitively coupled to amplifier.

### 3. AURAL

Internally mounted speaker, volume controlled manually from zero output to maximum loudness. One audible click is heard per incident of detected radiation.

### 4. ALARM

a. Alarm Point: Locking type, adjustable over the meter scale from 1/10 scale to over full scale.

b. Visual Alarm: Red light on front panel.

c. Audible Alarm: 1000 Hz tone on speaker, independent of volume control setting.

d. Modifications: The alarm may be changed to a non-locking type. See Section III, C, 2.

### 5. COUNTING MODE

a. Gross Counting: Input sensitivity approx. 10 mv into 25K ohms impedance.

b. PHA:

(1) Threshold: Approx. 10 mv.

(2) Window Width: Adjustable by a card mounted control from 0 to at least double the input sensitivity. Further adjustment takes width to infinite.

## 6. POWER

a. Line: 3 wire, 105V-125V, 50-60 Hz at approx. 0.1 amps.

b. Battery:

(1) Type: 6.25V nickle-cadmium battery continuously charged with instrument plugged into line.

(2) Charging Rate: 10 ma with instrument on, 35 ma off.

(3) Charging Time: Approx. 50 hours to full charge from full discharge with circuit off.

## 7. PORTABILITY

Instrument may be operated away from AC power source with a full charge on battery for approx. 50 hours.

## 8. ENVIRONMENTAL

a. Temperature: The instrument is operational from -20°F to +140°F with less than ±10% of full scale change in calibration or ±20% of full scale change in alarm point. The typical change over this range for high voltage is less than ±3%.

## 9. MECHANICAL

a. Size: Height: 5-1/4"
Depth: 7"
Width: 7-1/2"

b. Weight: 5 lbs.

## 10. DETECTOR REQUIREMENTS

a. General:

(1) Operating Voltage and Current: Any voltage from +200 to 2800 volts DC; current up to 20 microamps from any voltage up to 1300 volts.

(2) Connection: Single coaxial, positive high voltage and ground.

(3) Pulse Height: Minimum pulse height of interest must be at least 10 millivolts negative with a rise time of less than 1 microsecond.

b. PHA:

To use the pulse height analyzer feature, the amplitude of the output pulses from the detector must be proportional to the energy of the radiation and vary with the high voltage applied.

Any detector that meets the requirement for PHA will also work for gross counting.

# SECTION II

# OPERATION

## A. DESCRIPTION OF CONTROLS AND CONNECTORS

### 1. EXTERNAL (Figures 1-1 and 2-2)

a. Switch: Six position switch turns instrument OFF, checks BATTery condition, and selects scale multipliers of X1, X10, X100 and X1K. This number must be multiplied by the meter reading to obtain the proper count rate.

b. RESPONSE: Toggle switch to set response time either FAST or SLOW for best compromise between speed of reading and fluctuation for the particular usage.

c. RESET: Discharges integration capacitor, bringing the meter reading to zero rapidly, also releasing an alarm condition.

d. PHA/GROSS: Toggle switch selects whether all pulses above threshold are counted (GROSS), or only those that are within the window (PHA).

e. DETECTOR: Connection to detector, MHV series coaxial.

f. VOLUME: Varies loudness of speaker from no sound to maximum loudness.

g. RECORDER: Connection for external 50ua recorder. May be changed to 10 mv. See Section III, C, 1.

h. SCALER: BNC series coaxial. Connection to external scaler.

i. ALARM SET: Controls point on meter scale that the alarm will actuate. Numbers 1 thru 5 correspond to bold increments on meter scale.

j. H. V. ADJ.: Pot to adjust high voltage according to use of instrument.

### 2. INTERNAL (Figure 2-1)

a. Calibration Controls: One control for each range which individually calibrates that range to agree with input count rate. Multi-turn pots mounted on printed circuit board.

b. Alarm Set Calibrate: Multi-turn pot to calibrate alarm set pot to agree with meter reading.

c. Window: Multi-turn pot to control window width when using instrument in the PHA mode.

## B. PREPARATION FOR USE

### 1. INSPECTION

The instrument should be checked for physical damage.

### 2. CONNECTIONS

a. Connect the cable to the instrument and the detector to the cable.

b. Plug AC cord into 115V, 60 Hz line. AC ON light should light.

## C. USING THE INSTRUMENT

### 1. STARTING

Turn the switch to BATTery check. The meter should indicate in the BATT OK area.

### 2. OPERATION CHECK

With the PHA-GROSS switch in GROSS position, place a check source in a repeatable position adjacent to the detector to achieve an upscale reading. Note that the reading is sensitive to the position of the source. The reading may be recorded for future reference.

Push the RESET button and the reading should drop to zero rapidly, then climb back to source reading when RESET is released. The RESPONSE switch may be selected for the best compromise between speed of reading and meter fluctuation.

Rotate the ALARM SET counterclockwise until alarm occurs. Alarm light should light and 1000 Hz squeal will be heard on the speaker. Push the RESET button; the alarm condition should go away until reading exceeds ALARM SET point.

### 3. INTERPRETATION OF INDICATIONS

The meter reading must be multiplied by the scale switch setting to obtain the proper number. The fluctuation of the meter is normal and is caused by the random nature of radioactive decay.

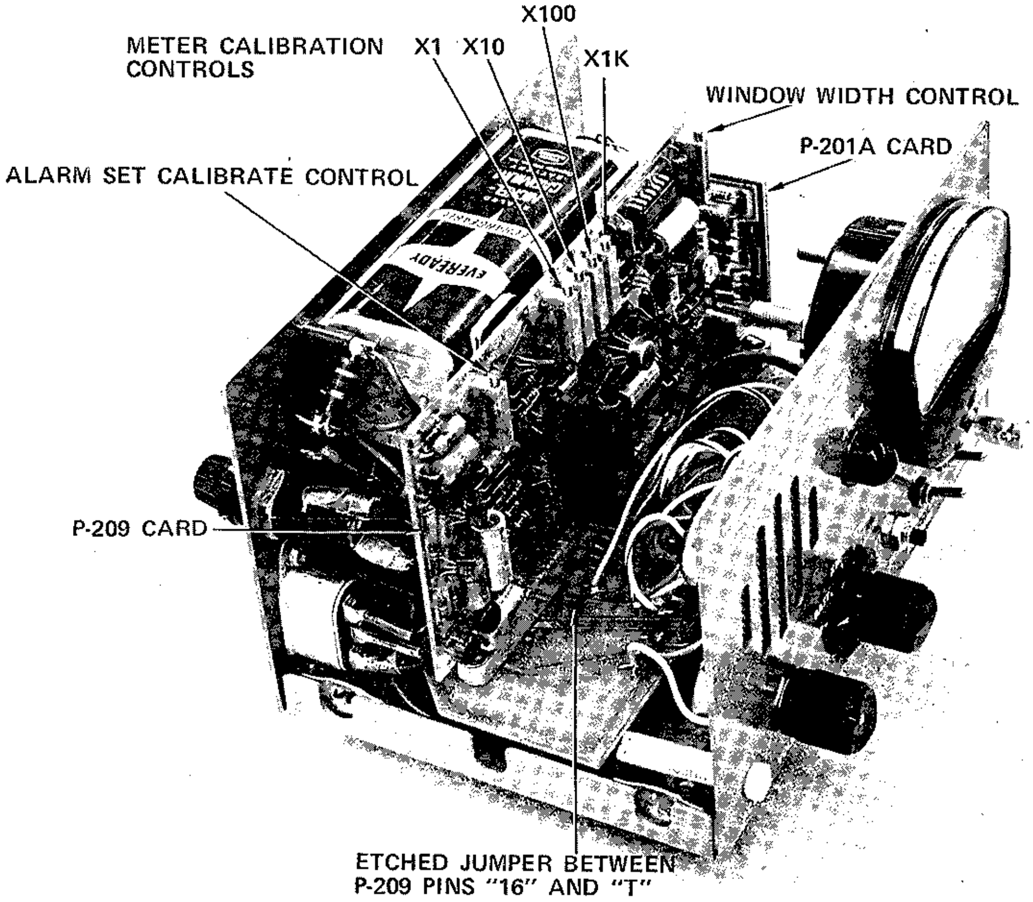
X100
METER CALIBRATION CONTROLS
X1
X10
X1K
WINDOW WIDTH CONTROL
P-201A CARD
ALARM SET CALIBRATE CONTROL
P-209 CARD
ETCHED JUMPER BETWEEN P-209 PINS "16" AND "T"

*Figure 2-1. Top View, Cover Removed*

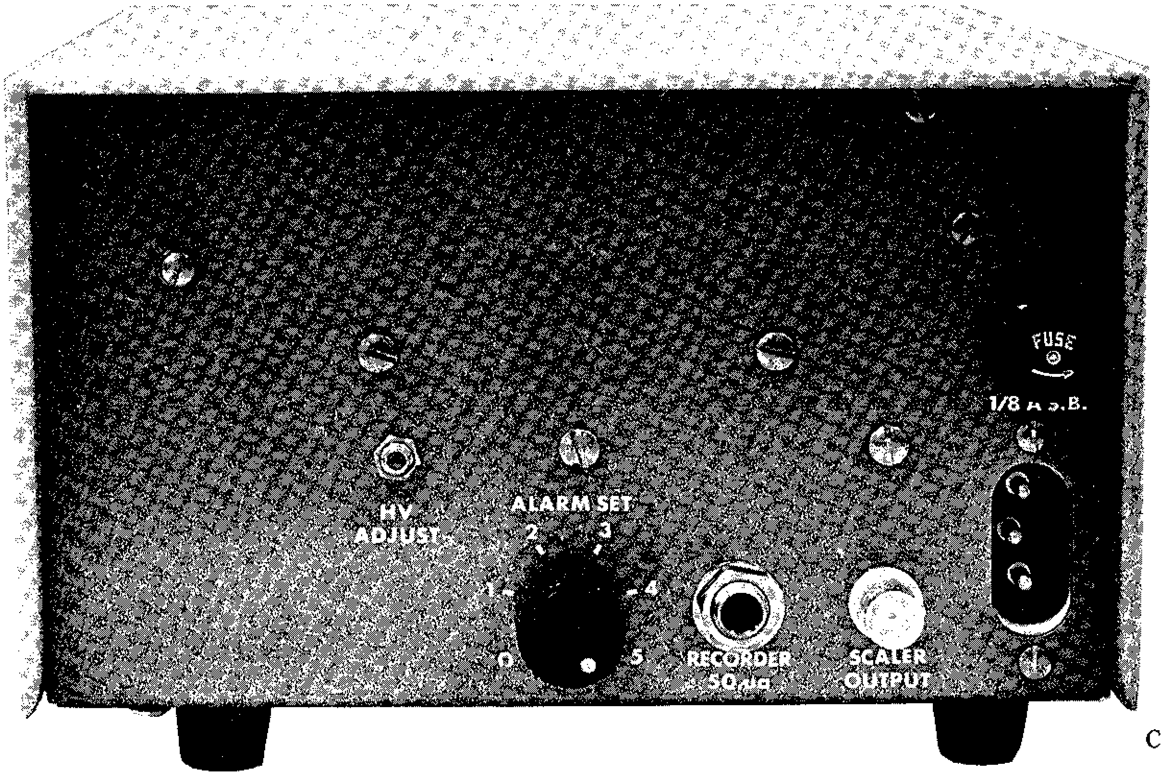

*Figure 2-2. Rear View, Cover in Place*

## SECTION III

## THEORY OF OPERATION

### A. GENERAL

The high voltage supply (P-201A) develops high voltage for the detector. When radiation reacts in the detector, negative pulses are generated. These pulses are coupled into an amplifier.

After amplification, the pulses are applied to a pulse height analyzer, which can be disabled for gross counting.

The output of the pulse height analyzer is coupled to a trigger circuit, and the trigger converts these pulses to standard width pulses. These standard pulses are applied to the meter driver which converts them to standard pulses of current, averages this current, and drives the meter. Thus the meter reading is proportional to the average rate of radiation at the detector.

The voltage across the meter is applied to a differential amplifier whose reference voltage is controlled by the ALARM SET control. When the meter voltage exceeds the reference voltage, the amplifier sustains an alarm condition which lights the alarm light, turns on the alarm oscillator and couples its frequency to the speaker.

### B. FUNCTIONAL THEORY

#### 1. HIGH VOLTAGE SUPPLY (P-201A)

This unit consists of a controlled oscillator (Q101), voltage step-up and rectification (T101 [10417-C01]), HV division (R112, R106, R107, R108 and R109), differential amplifier (Q104, Q105, Q106), amplifier (Q103), and oscillator control (Q102).

The high voltage regulates when the voltage on Q104 gate and Q105 gate is equal. The high voltage will be a multiple of the voltage on the gates, approx. 345 times. The high voltage is varied by varying the voltage on the reference side (gate Q104) with R202, HV adjust. As the reference is increased, the differential amplifier is unbalanced, which increases the level of the oscillator and the high voltage output. This puts more current thru the HV reference resistors, increasing the voltage on the sensing input (Q105 gate) and rebalances the circuit at a higher voltage.

A heavier load tends to lower high voltage, unbalancing the differential amplifier. This increases the level of the oscillator, to maintain the original output.

Changes in battery voltage are compensated by R110.

The differential amplifier is a matched pair (Q104, Q105) for temperature stability. Q106 is a current source.

Change in temperature is compensated by CR102.

The maximum output can be increased by replacing R112 with a regulator tube. The minimum high voltage will then be approx. 200V above the regulator tube voltage, and the maximum will be approx. 1200V above the regulator tube voltage.

#### 2. AMPLIFIER

The amplifier portion of the P-209 card consists of Q1, A1, Q3 and associated circuitry. Q1 is an emitter follower giving a high input impedance. A1 is an integrated circuit amplifier whose non-inverting gain is controlled by R7. Q3 is an inverting amplifier that is held cut off by R8 and R10. A pulse input turns Q3 on and the resulting increase in current causes a positive pulse on R11. The full amplitude pulse and any fraction of the pulse off the arm of R11 form the two inputs to the pulse height analyzer.

#### 3. PULSE HEIGHT ANALYZER

Integrated circuit A2 is a quad 2 input gate connected as two independent monostable multivibrators. The two multivibrators have equal input sensitivity, so the difference in amplitude of the two inputs (this difference adjustable by R11) create the range of pulse heights that will be counted. When multivibrator 1 (pins 5, 6, 7, 8, 9, 10) flips, the output on pin 5 turns Q4 on. If multivibrator 2 (pins 1, 2, 3, 12, 13, 14) flips, its output on pin 3 causes multivibrator 1 to shut off which prevents Q4 from turning on. The RC time constant of R14 and C6 delays Q4 turn on until multivibrator 2 has time to turn on and disable multivibrator 1. Thus, if the input pulse height is large enough, both multivibrators flip and no output results; if the input pulse height is within the set range (window), multivibrator 1 only flips and an output exists. With R11 adjusted towards the ground end (CW), no pulse large enough to trigger multivibrator 2 can be developed, which results in an infinite window (all pulses will be counted).

The PHA-GROSS switch, when in the GROSS position,

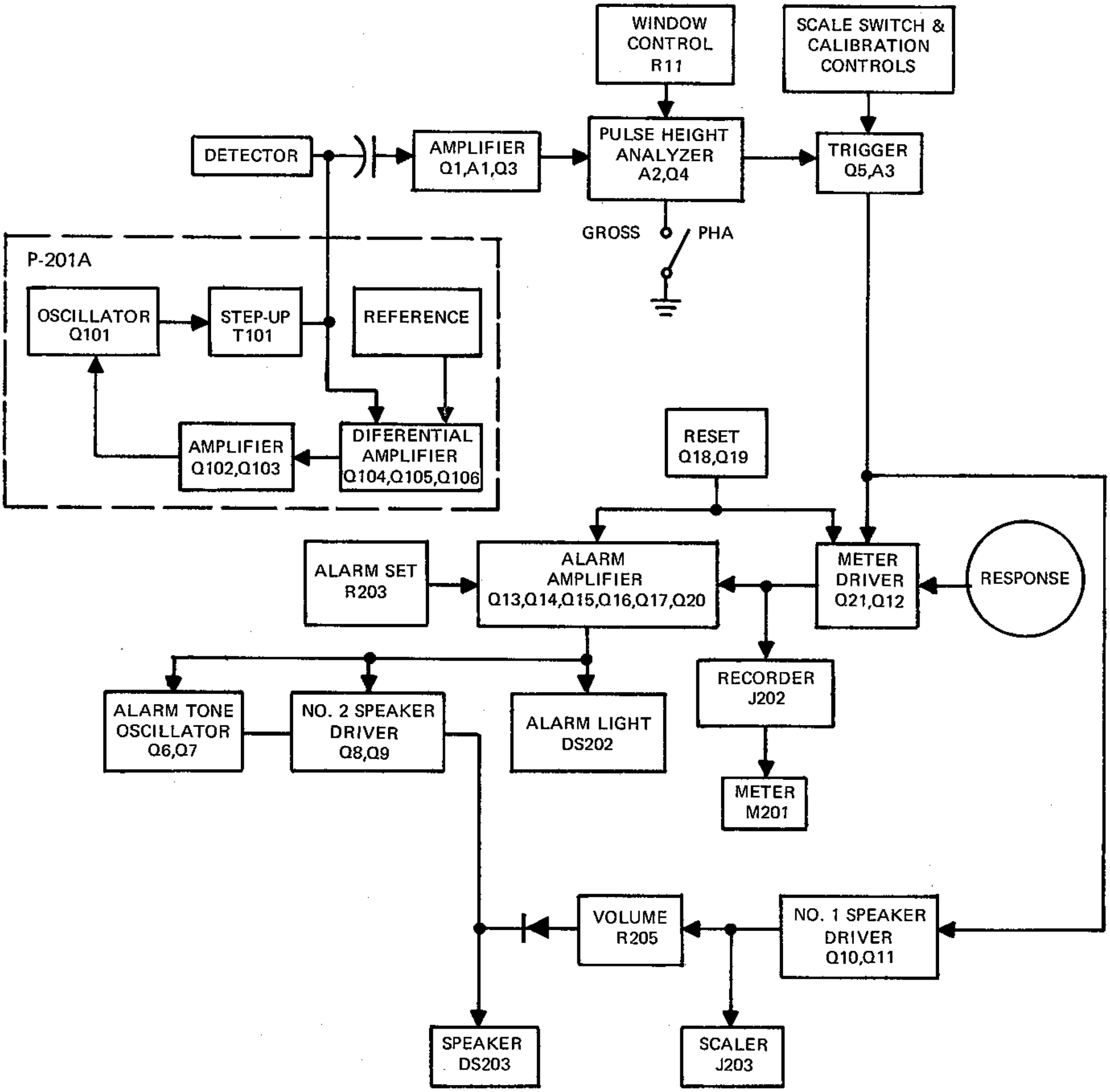

*Figure 3-1. System Block Diagram*

disables multivibrator 2 which results in an infinite window at all times.

### 4. TRIGGER

Q5 inverts the signal from the pulse height analyzer and starts the trigger.

Integrated circuit A3 is a dual 2 input gate connected to operate as a monostable multivibrator whose pulse width is controlled by the RC time constant between its pins 7 and 3. This time constant is established by the setting of S201A (scale switch) which selects a particular R and C. The calibration controls (R19, R20, R21, R22) form the R for each scale, making the pulse width continuously variable for calibration.

When the trigger is initiated by a pulse from Q5, the output at pin 6 goes positive and holds until the predetermined time (RC) elapses.

### 5. METER DRIVER

The driver, Q12, is normally off, so no current flows thru the meter, M201. When the trigger is on, Q12 is turned on and current flows. The amount of current is determined by the voltage on the base of Q12 and R34. The length of time that current flows is determined by the pulse width of the trigger. This (current times time) forms a certain charge which is transferred to C15 (or C15 and C14, depending on response switch setting) for each event counted. C15 discharges thru M201, yielding a certain average current dependent on the rate of input pulses. Changing the pulse width (i.e., changing scales or calibration pot setting) changes the average current for a given input pulse rate. This allows the meter to be calibrated to read counts per minute at the detector.

The response time is controlled by the RC time constant of C15 and R35 and R36 in the fast position, of C14 + C15 and R35 and R36 in the slow position.

### 6. SPEAKER DRIVER NO. 1

Q11 and Q10 amplify the trigger pulse and drive the speaker. One click is heard for each event counted. Q10 also drives the external scaler. Speaker loudness is controlled by R205 setting.

### 7. ALARM AMPLIFIER

Q13, Q14, Q15 and Q16 form a differential amplifier with the ALARM SET, R203, controlling the reference side of the amplifier. The voltage across R203 is held stable by current source CR9. Alarm point is set by adjusting the reference voltage on the base of Q16, i.e., adjusting R203. As the meter is driven upscale, the voltage on the base of Q13 increases proportionally with meter reading. When the voltage on the base of Q13 equals, or exceeds, the voltage on Q16 base, Q17 will conduct, turning on Q20, lighting the alarm light and activating the alarm tone oscillator and No. 2 speaker driver. The alarm condition is locked in by the feedback loop consisting of R40 and CR7 which holds Q17 in conduction.

When the RESET switch is closed, a voltage is applied to the base of Q18 and Q19, turning them on. Q18 returns the base of Q13 to near zero and also removes the charge from C14 and C15, returning meter reading to zero. Q19 puts the base of Q20 at ground, turning Q20 off. With Q20 off, Q17 is turned off, the alarm light is turned off, and the alarm tone osc. and No. 2 speaker amplifier are disabled, resetting the alarm amplifier.

### 8. ALARM TONE OSCILLATOR AND SPEAKER DRIVER NO. 2

Q6, Q7 and associated circuitry make up an astable multivibrator whose frequency is amplified by Q8 and Q9, which drive the speaker.

When Q20 is turned on (an alarmed condition) Q6, Q7, Q8 and Q9 are enabled by their emitters getting to ground.

### 9. POWER CIRCUITRY

The AC line voltage is stepped down by T201 and rectified by A201, and is used to trickle charge BT101. The charging current is set by R201. Since the line is not switched, the battery will be charging any time the instrument is plugged into the line, and the AC ON light will be lit.

The low voltage is regulated by Q2 and CR2.

## C. MODIFICATIONS

### 1. RECORDER OUTPUT

The output signal can be changed from 50ua to 10 millivolts full scale by adding a 200 ohm resistor across the output terminals.

### 2. ALARM

The alarm can be made non-locking by cutting the etched jumper on the mother board (between P-209 socket pins "16" and "T"). See Figure 2-1.

### 3. HIGH VOLTAGE

The maximum high voltage can be raised by replacing R112 with a regulator tube.

# SECTION IV

# MAINTENANCE

## A. DISASSEMBLY AND REASSEMBLY

1. To remove cover, loosen the two 1/4 turn fasteners on each side of the unit and lift the cover off.

2. To remove P-201A board, remove retaining screw and pull module out.

## B. PREVENTIVE MAINTENANCE

1. Keep instrument clean and dry.

2. Whenever possible, keep unit plugged into line when not in use.

## C. CALIBRATION (For control locations see Figure 2-1)

### 1. COUNT RATE

Calibration is made to true frequency. Capacitively couple a pulse generator to the DETECTOR connector using a capacitor with a 3KV voltage rating (in lieu of the capacitor, remove P-201A module). The pulse generator must have a negative pulse whose amplitude is greater than 10 millivolts with a rise time less than 1 microsecond, and a frequency range covering that of the instrument. Adjust the pulse generator to correspond to approx. 3/4 scale (400) and adjust the calibration control for the range selected until the meter reading agrees with the input frequency. Repeat for each range (X1, X10, X100 and X1K).

### 2. ALARM SET CALIBRATE

Insert a signal into the instrument to obtain a reading on the meter at 400 (See No. 1, above). Turn ALARM SET control to 4. Adjust ALARM SET CAL pot until an alarm condition marginally occurs.

### 3. GROSS COUNTING

With PHA-GROSS switch in GROSS position, connect detector to DETECTOR connector. The proper setting for the high voltage is to operate on the detector plateau, below the threshold of noise or unwanted radiation (See Figure 4-1). This setting is best determined as follows:

a. Plot a plateau (CPM vs. Voltage) with the detector counting the type of radiation of interest.

b. Plot a second plateau with the detector counting the type of radiation to be rejected (i.e., gamma for an alpha detector).

c. From the two plateau curves a voltage is picked and the instrument adjusted to that voltage.

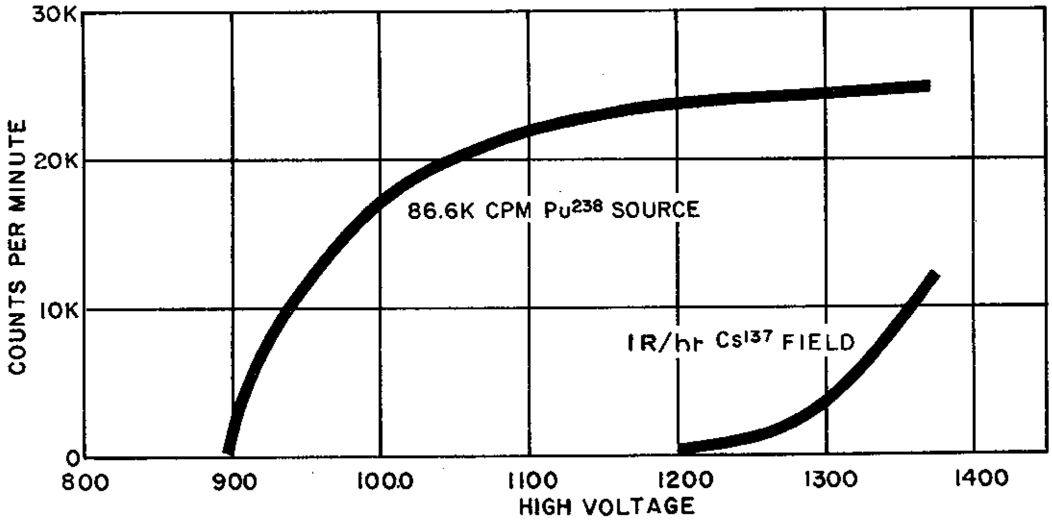

*Figure 4-1. Typical AC-3 Response on RM-15*

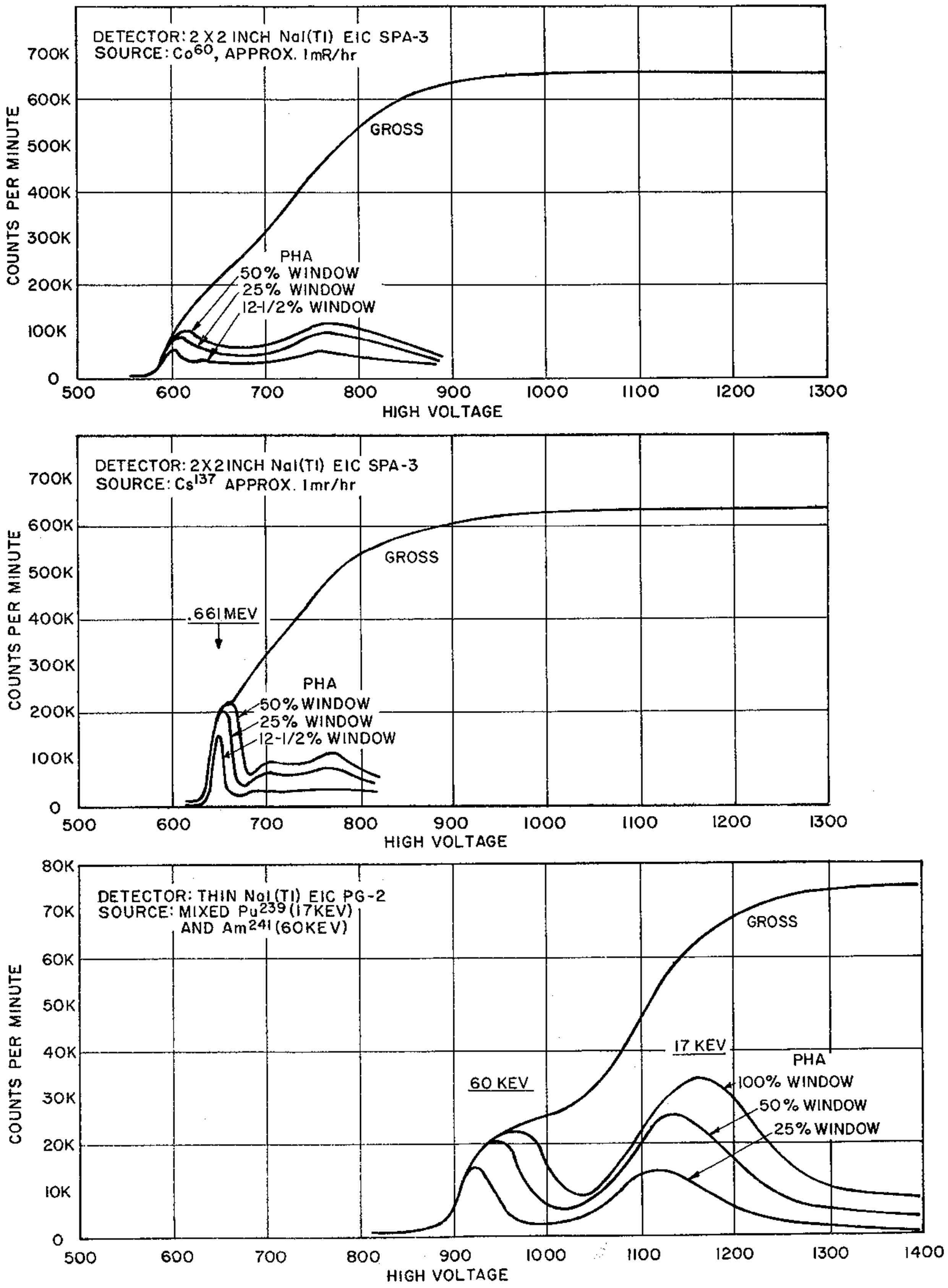

*Figure 4-2. Typical RM-15 Response*

**NOTE**

If the instrument is to be used for gross counting only, turn the WINdow control (Fig. 2-1) fully clockwise. This gives the instrument an infinite window so the PHA-GROSS switch will have no affect should it be inadvertently switched to PHA.

**CAUTION**

The H.V. supply may have a voltage capability exceeding the detector rating. DO NOT turn the H.V. ADJUST to maximum without observing either noise or plateau.

4. PULSE HEIGHT ANALYZER, COUNTING (See Section I, B, 10, b)

a. WINdow Adjustment: The WINdow pot adjusts the range of pulse heights that will be counted and, once set, remains a fixed percentage for any energy of interest.

The window width is expressed as a percentage of the threshold, which is found by:

$$\frac{\text{Window Width (mv)}}{\text{Threshold (mv)}} \times 100 = \%\ \text{Window}$$

For example, with a threshold of 10 mv, and a 50% window, the window width is 5 mv, and all pulses between 10 and 15 millivolts in amplitude will be counted.

The window width should be optimised to the particular detector and energy of interest. Figure 4-2 will aid in setting % window.

b. High Voltage Setting: Since the pulse height from the detector is proportional to the energy of the radiation at the detector, and high voltage varies the pulse height of the pulses, any energy can be set in the window by high voltage setting.

Plot a response curve (CPM vs. H.V., Figure 4-2) exposing the detector to a source of the proper energy which is intense enough to obtain a reading well above background. If background radiation makes the source counting doubtful, it may be verified by removal and replacement of the source. The energy peak can then be identified with a high voltage setting.

Note that a higher energy requires a lower high voltage setting and vice versa. An RM-15, when shipped from the factory, has a high voltage span compatible with the specified detector and application. However, if the application has changed, it is possible to change the H.V. span. See Section III, C, 3.

5. CALIBRATION TO SOURCE (OPTIONAL)

Some detectors, such as the AC-3, may be calibrated to read 100% of 2 pi source value instead of true counts at the detector. To accomplish this:

a. Plateau as in No. 3, above.

b. Place probe on a source of known intensity and adjust calibration control for the range selected so the meter reading agrees with the 2 pi count rate of the source. This will have to be repeated for each range.

D. TROUBLESHOOTING

Typical voltages and waveforms are given on the schematic (Figure 6-1) and component locations are shown in Figure 6-2.

Voltages are measured with a 20,000 ohms per volt, or greater, voltmeter except the high voltage points. An electrostatic voltmeter should be used to check the high voltage.

# SECTION V

# PARTS LIST

| REF DESIG | PART | DESCRIPTION | MFR AND PART NO |
|---|---|---|---|
| 1. CHASSIS | | | |
| A201 | Bridge Rectifier | | Varo VS148 |
| BT201 | Battery | 6.25V, 900 MAH | Eveready N67 |
| C1 | Capacitor | 220 pf, 3KV | |
| CR201 | Diode | | 1N4001 |
| DS201 | Neon Indicator | White | Leecraft 36N2315 |
| DS202 | Lamp | | 328 |
| DS202X | Lamp Holder | Red Lens | Dialco 101-5030-0971-201 |
| DS203 | Speaker | | Lafayette S-433 |
| F201 | Fuse | 3AG, 1/8 Amp, Slo-Blo | |
| J201 | Connector | MHV, Bulkhead | Amphenol 270025 |
| J202 | Phone Jack | | Switchcraft 13B |
| J203 | Connector | BNC | UG-1094/U |
| M201 | Meter | 0-50 ua DC, with EIC 10472-B13 Face | Honeywell MM-2T |
| R1 | Resistor | 390K ±10%, 1/4W | |
| R201 | Resistor | 130 ±5%, 1W | |
| R202 | Potentiometer | 20K (H.V. ADJ.) | Bourns Trimit 274-1-203M |
| R203 | Potentiometer | 2.5K, Linear | RV4 Type |
| R204 | Resistor | 4.3K ±5%, 1/4W | |
| R205 | Potentiometer | 50 Ohm, Linear | Ohmite CMU5001 |
| R206 | Resistor | 180K ±5%, 1/4W | |
| R207 | Resistor | 10 Ohm ±10%, 1/2W | |
| S201 | Switch | | EIC 10545-B05 |
| S202, S204 | Switch | SPDT, Toggle | Alco MST-105D |
| S203 | Switch | SPST, N.O. Pushbutton | Grayhill 30-1 |
| T201 | Transformer | 12V | Stancor P-8391 |
| 2. ELECTRONICS BOARD, P-209 | | | |
| A1 | Integrated Circuit | Amplifier | RCA CA3022 |
| A2 | Integrated Circuit | Quad 2 Input Gate | MOT MC717P |
| A3 | Integrated Circuit | Dual 2 Input Gate | MOT MC710G or NSC 3010 or FSC U5B991029X |
| C2, C3 | Capacitor | .01 ±10%, 100V | TWR Type 608 |
| C4 | Capacitor | .0033 MFD ±10%, 200V | Sprague 192P-33292 |
| C5 | Capacitor | .0082 ±10%, 80V | Sprague 192P-8229R |

| REF DESIG | PART | DESCRIPTION | MFR AND PART NO |
|---|---|---|---|
| 2. ELECTRONICS BOARD, P-209 (CONTINUED) | | | |
| C6 | Capacitor | 220 pf, 100V | Aerovox MC80V221AM |
| C7, C17 | Capacitor | 120 MFD ±20%, 10V | Kemet K120C10 |
| C8 | Capacitor | .68 MFD ±10%, 50V | G. E. 75F6R5A684 |
| C9 | Capacitor | .068 MFD ±10%, 50V | G. E. 75F2R5A683 |
| C10 | Capacitor | .0068 MFD ±10%, 400V | G. E. 75F1R4A682 |
| C11 | Capacitor | .00068 MFD ±10%, 200V | Sprague 192P-68192 |
| C12, C18 | Capacitor | 0.1 MFD ±10%, 80V | Sprague 192P-1049R8 |
| C13 | Capacitor | .0047 MFD ±10%, 200V | Sprague 192P-47292 |
| C14, C19 | Capacitor | 330 MFD ±20%, 6V | Kemet K330C6 |
| C15 | Capacitor | 33 MFD ±20%, 6V | Kemet K33C6 |
| C16 | Capacitor | 3.3 MFD ±20%, 10V | Kemet K3R3C10 |
| CR1, CR4, CR7 | Diode | | 1N914 |
| CR2 | Zener Diode | 5.3V | 10416-A24 |
| CR3, CR5 | Diode | | MOT MZ2361 |
| CR6, CR8 | Diode | | 1N4001 |
| CR9 | Current Source | | MOT 1N5289 |
| Q1, 2, 4, 6, 7, 8, 11, 13, 14, 15, 16, 18, 19, 21 | Transistor | | 2N4124 |
| Q3, 5, 12, 17 | Transistor | | 2N4126 |
| Q9, Q10 | Transistor | | 2N3638 |
| Q20 | Transistor | | 2N4401 |
| R2, R5, R41 | Resistor | 4.7K ±10%, 1/4W | |
| R3 | Resistor | 68K ±10%, 1/4W | |
| R4 | Resistor | 33K ±10%, 1/4W | |
| R6 | Resistor | 68 ±10%, 1/4W | |
| R7, 15, 40, 42 | Resistor | 2.7K ±10%, 1/4W | |
| R8, 14, 16, 43 | Resistor | 10K ±10%, 1/4W | |
| R9 | Resistor | 330 ±10%, 1/4W | |
| R10 | Resistor | 100K ±10%, 1/4W | |
| R11 | Potentiometer | 5K | Amphenol 3800P or equal |
| R12 | Resistor | 3K ±10%, 1/4W | |
| R13 | Resistor | 3.3K ±10%, 1/4W | |
| R17, R32 | Resistor | 2.2K ±10%, 1/4W | |
| R18, 23, 26, 30, 31 | Resistor | 6.8K ±10%, 1/4W | |
| R19, 20, 21, 22, 36 | Potentiometer | 10K | Amphenol 3800P or equal |
| R24, R25 | Resistor | 51K ±10%, 1/4W | |
| R27 | Resistor | 22K ±10%, 1/4W | |
| R28, R29, R34 | Resistor | 120 ±10%, 1/4W | |
| R33, R39 | Resistor | 470 ±10%, 1/4W | |
| R35 | Resistor | 12K ±10%, 1/4W | |
| R37 | Resistor | 1.2K ±10%, 1/4W | |
| R38 | Resistor | 680 ±10%, 1/4W | |

| REF DESIG | PART | DESCRIPTION | MFR AND PART NO |
|---|---|---|---|
| 3. HV SUPPLY, P-201A CIRCUIT BOARD | | | |
| C101 | Capacitor | .047 MFD ±10%, 200V | Sprague 192P47392 |
| C102 | Capacitor | 3.3 MFD ±20%, 10V | Kemet K3R3C10 |
| C103 | Capacitor | 120 MFD ±20%, 10V | Kemet K120C10 |
| CR101 | Diode | 2500 PIV | Dickson DR51028C or Semtech SC-25 |
| CR102 | Diode | | 1N34A |
| CR103 | Diode | | Motorola MR2361 |
| Q101 | Transistor | | Fairchild 2N3638 |
| Q102, Q106 | Transistor | | Motorola 2N4124 |
| Q103 | Transistor | | Motorola 2N4126 |
| Q104, Q105 | Transistor | Matched Pair FET, Vgs matched within 15 mV at 300 Ua Id at -40°C, 25°C and 100°C. Vgs max 1.5 volts at Id=300Ua TI TIS 70 or equal | |
| R101 | Resistor | 470 ±10%, 1/4W | |
| R102 | Resistor | 3.3K ±10%, 1/4W | |
| R103 | Resistor | 1.2K ±10%, 1/4W | |
| R104 | Resistor | 680 ±10%, 1/4W | |
| R105 | Resistor | 3.9K ±10%, 1/4W | |
| R106-R108 | Resistor | 22 Mego ±10%, 1/4W | |
| R109 | Resistor | 160K ±5%, 1/4W | |
| R110 | Resistor | 4.7 Mego ±10%, 1/4W | |
| R111 | Resistor | 68K ±5%, 1/4W | |
| R112 | Resistor | 10 Mego ±10%, 1/4W | |
| R113 | Resistor | 10K ±10%, 1/4W | |
| R114 | Resistor | 33K, ±5%, 1/4W | |

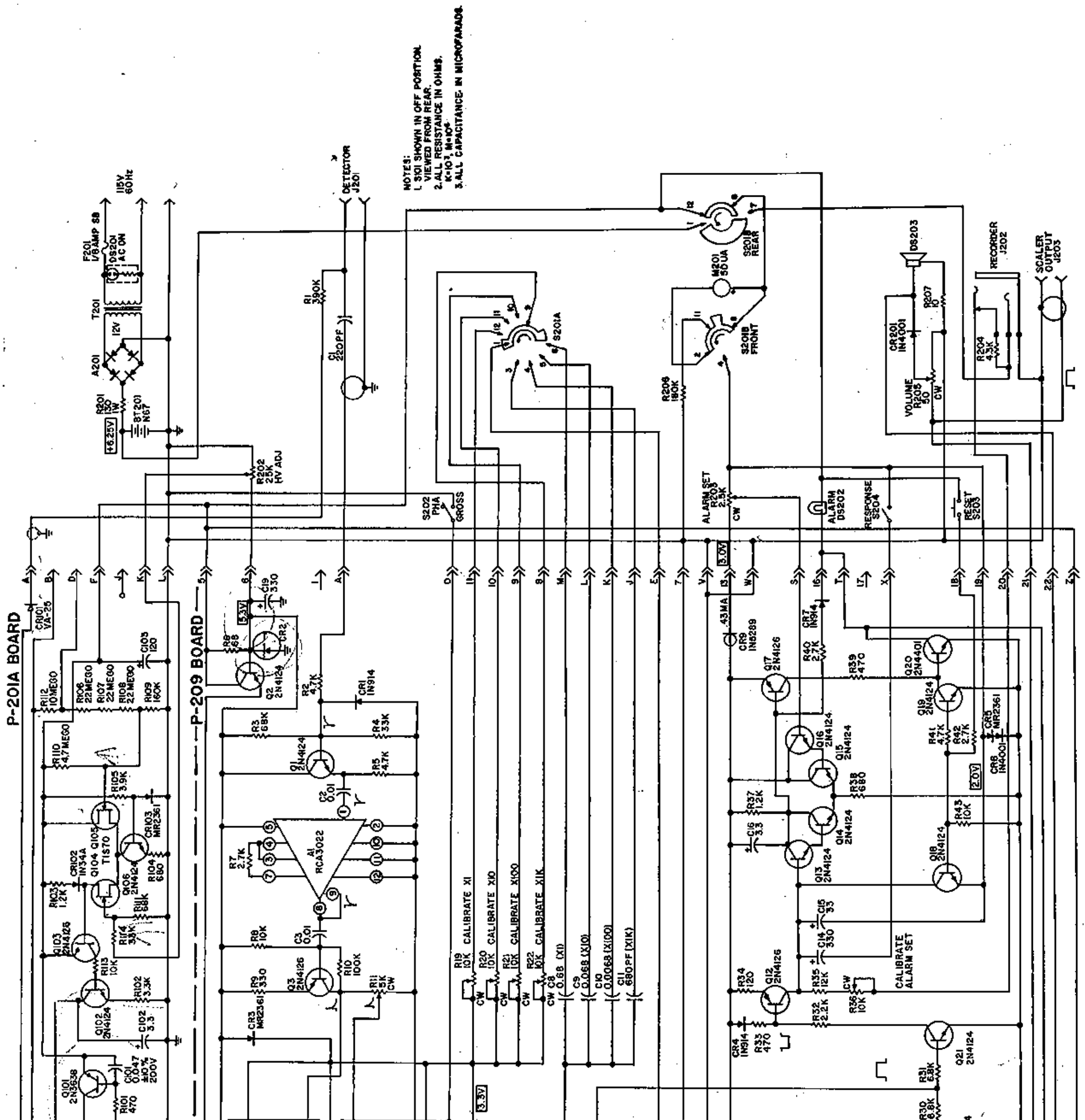

Figure 6-1. General Schematic of Model RM-15

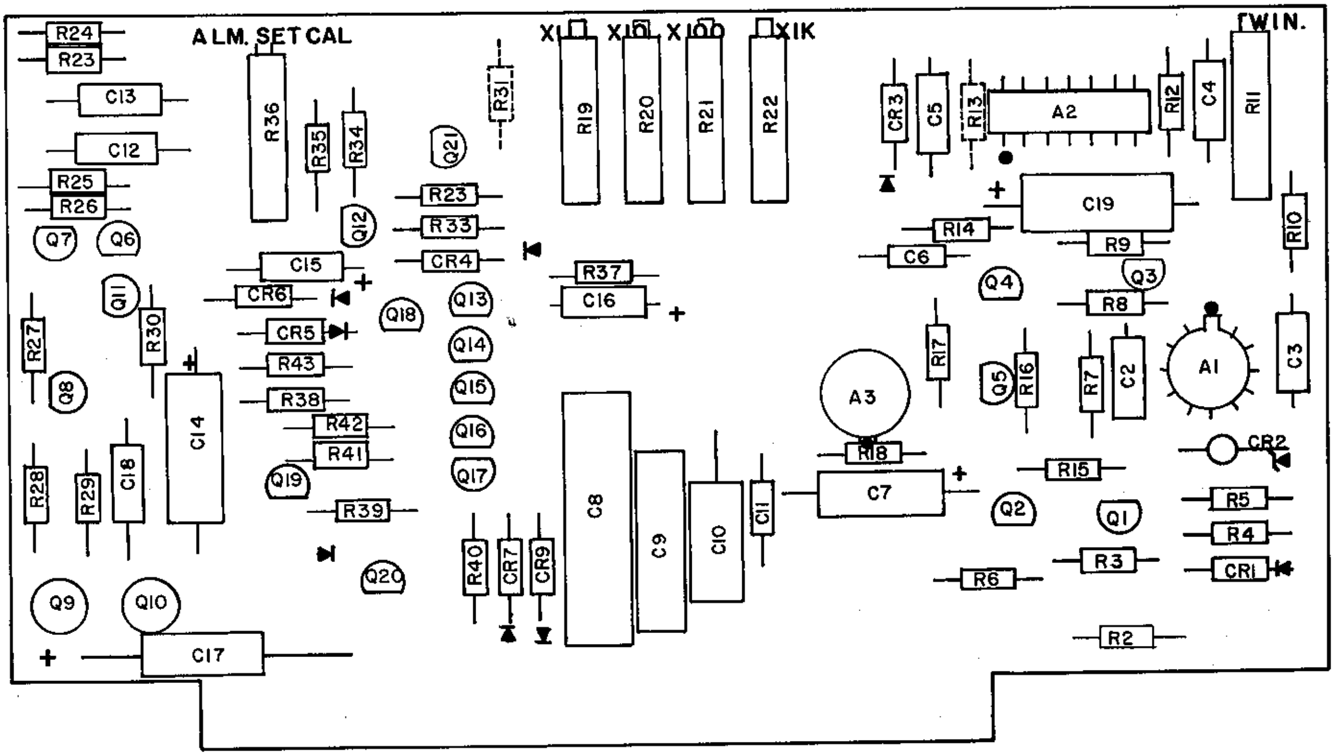

*Figure 6-2. Component Layout of P-209 Circuit Board*

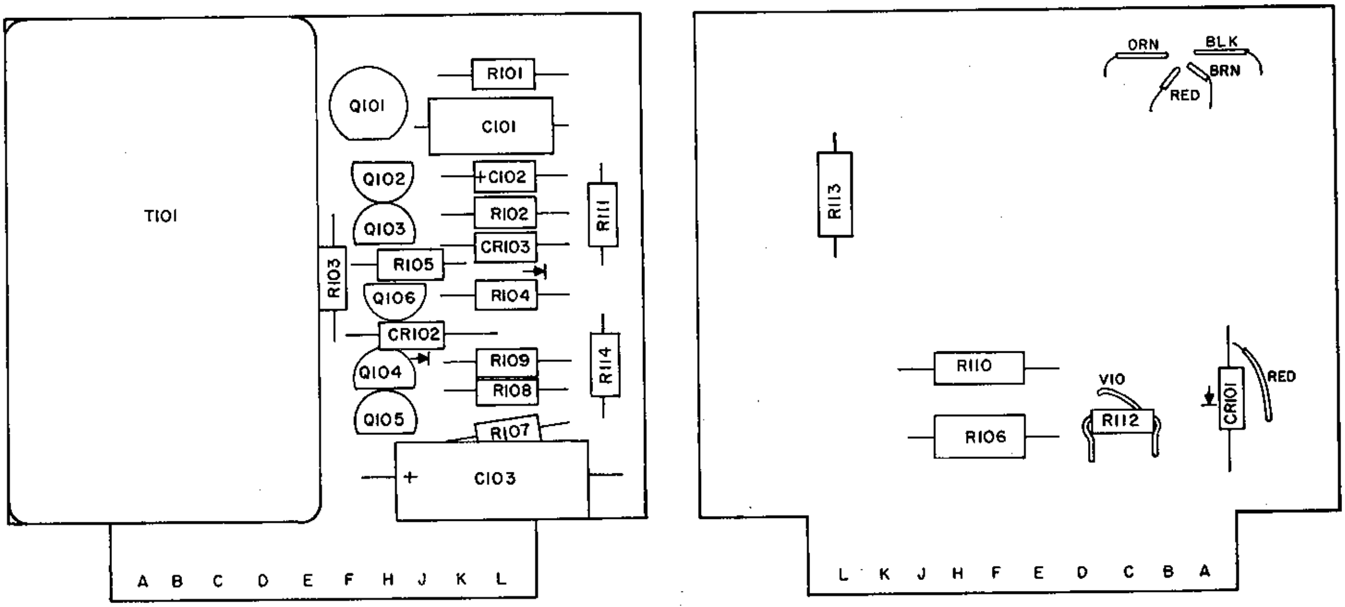

*Figure 6-3. Component Layout of P-201A Circuit Board*